RegioneEmilia-Romagna

CENTRAL EUROPE
COOPERATING FOR SUCCESS.

EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND

GUTS

GUTS: Green Urban Transport Systems Project
FINAL CONFERENCE

Visions and measures concerning alternative fuels adopted in Emilia-Romagna Region

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Mobility and Public Transport Department, Emilia-Romagna Region

4 April 2013 – Sopron (Hungary)

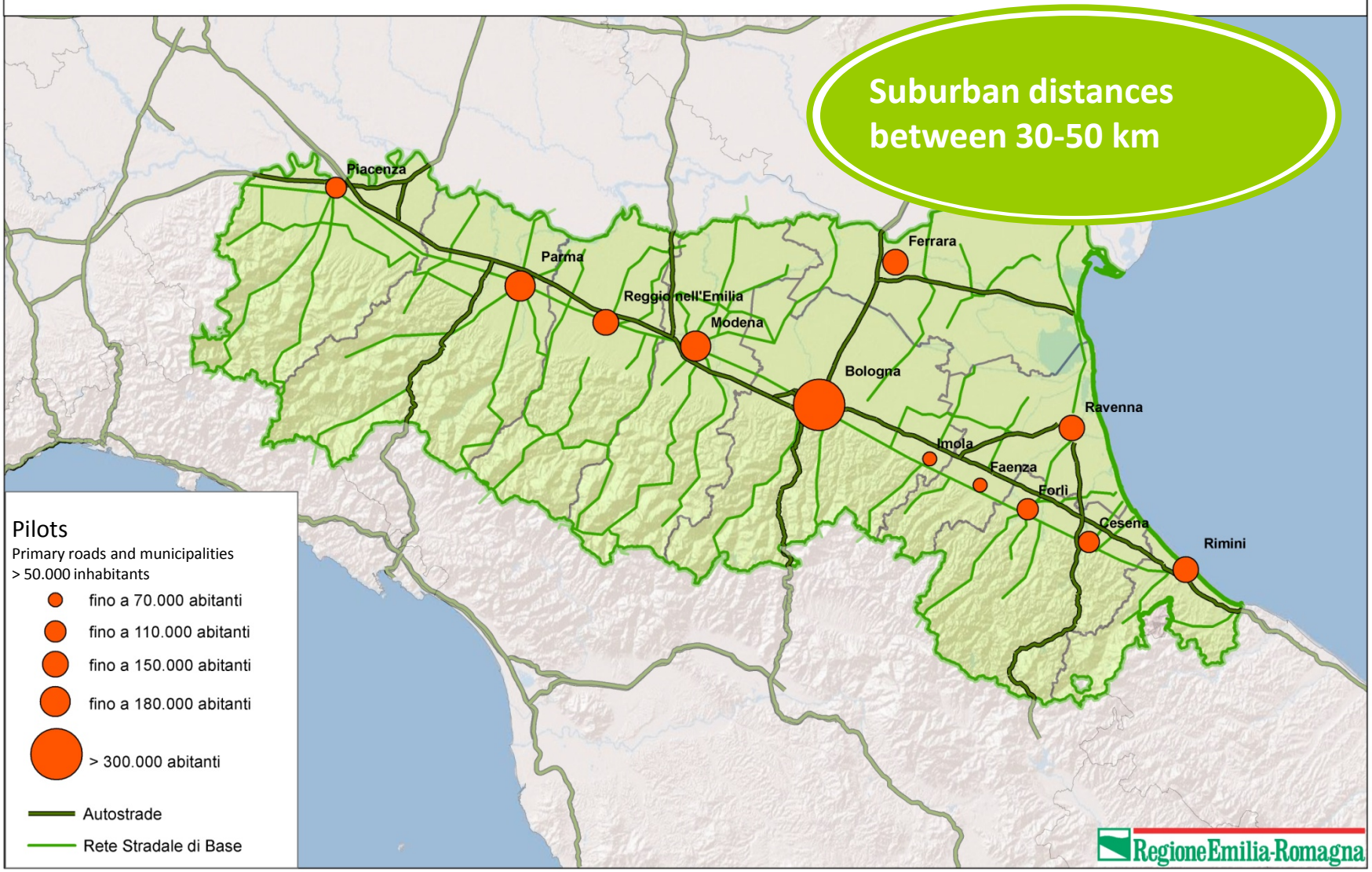


SUMMARY

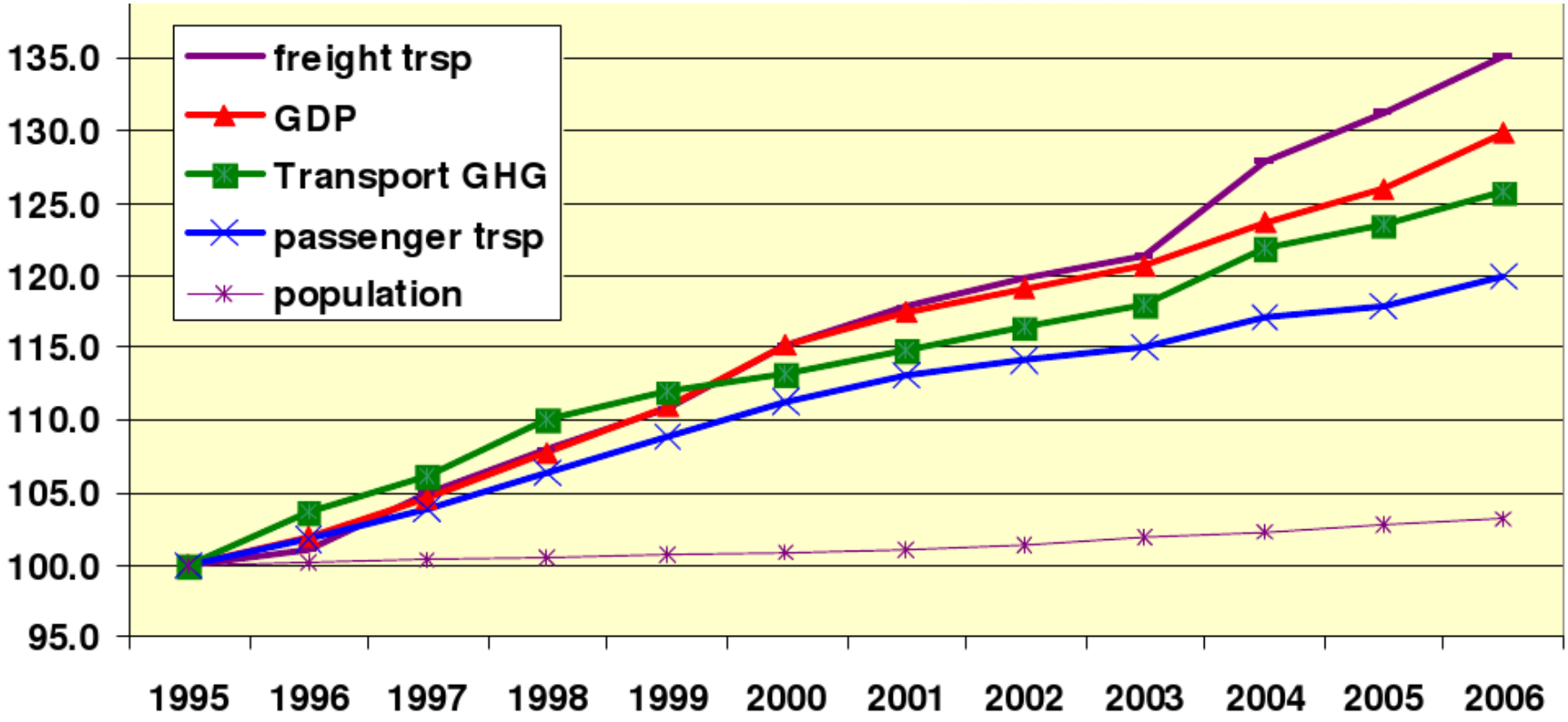
- Visions and measures on alternative fuels and electric mobility : the Emilia-Romagna case and the european Projects supporting of regional policies
- Problem to be solved
- Comparison among transport systems
- Battery electric vehicles, hybrids and fuel cells EV
- Conclusions

TERRITORIAL FRAMEWORK

Primary roads and municipalities > 50.000 inhabitants

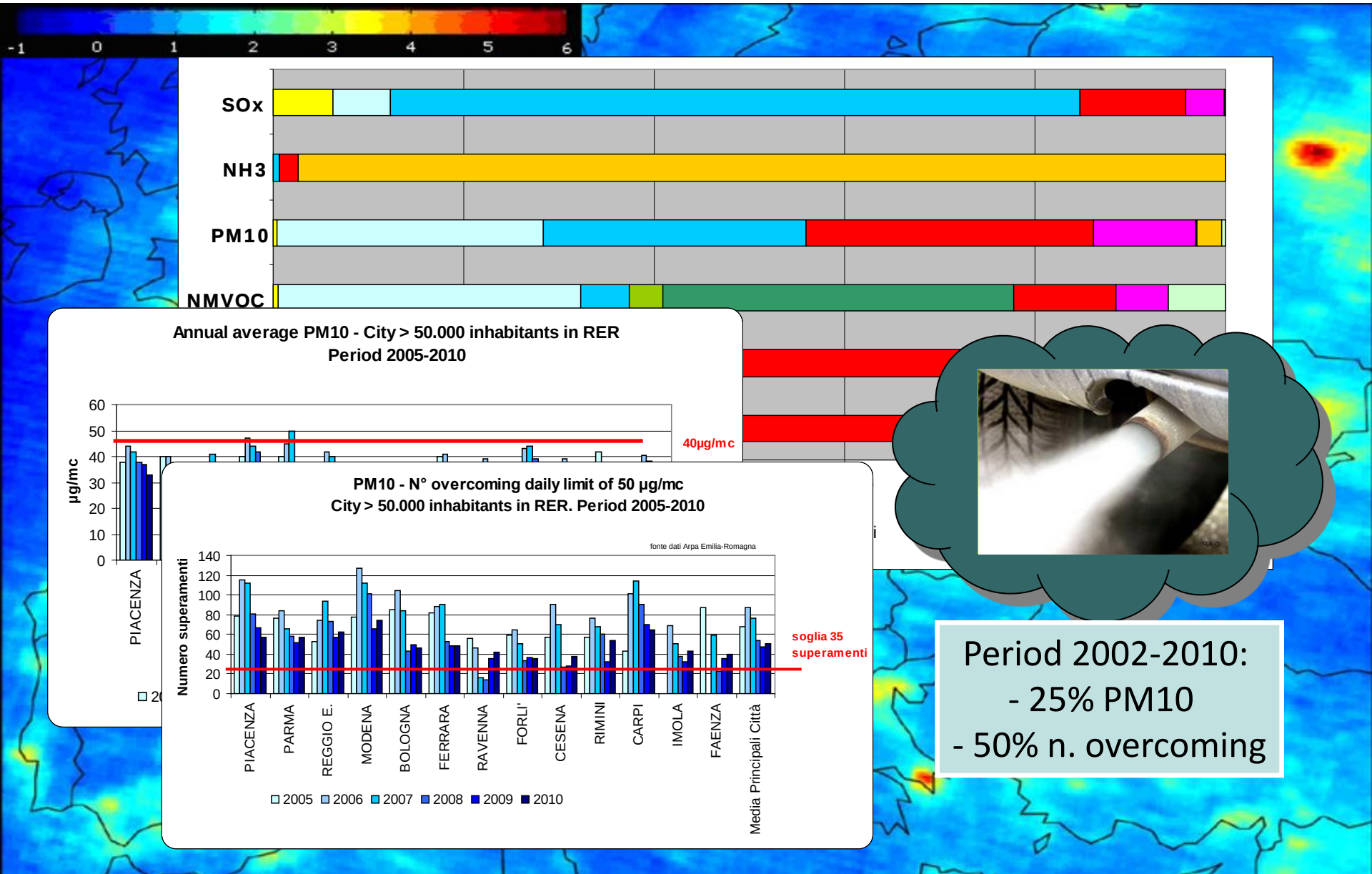


EU TRANSPORT AND CO2 EMISSIONS



EU goal: reduce **transport** carbon emissions by 60% below 1990 levels by 2050!

ENVIRONMENTAL PROBLEMS



Period 2002-2010:
- 25% PM10
- 50% n. overcoming

INTERDISCIPLINARY APPROACH

NEW
PRIT 2010-2020

PER
Regional Energy Plan
2011-2013

Health plan
2009-2011

Environmental Plan
2011-2013

- **Sustainable mobility**
- **Electric mobility**

European Union
European Regional Development Fund
RegioneEmilia-Romagna
INTERREG IVC
INNOVATION & ENVIRONMENT
REGIONS OF EUROPE SHARING SOLUTIONS
Made possible by the INTERREG IVC programme

REGIONAL ACTIONS FOR SUSTAINABLE MOBILITY

- Regional agreements on Air Quality with Provinces and Municipalities
- Support for local policies: anti-smog actions; LPT development…
- Sustainable Mobility Plan 2003-2005
- DPF, New buses, Cycle network, Sustainable mobility, City Logistics
- Regional funds for Methane/LPG conversion: 13MLN €
- Funds for DPF installation: 4MLN €
- Mi Muovo Elettrico (Electric Mobility)
- Bike sharing, Car sharing
- Incentives for the Municipality of Bologna to purchase pedelec
- Incentives for rail freight transport LR15/09
- New rail yards

since 2002

68 MLN €

30.000 vehicles converted

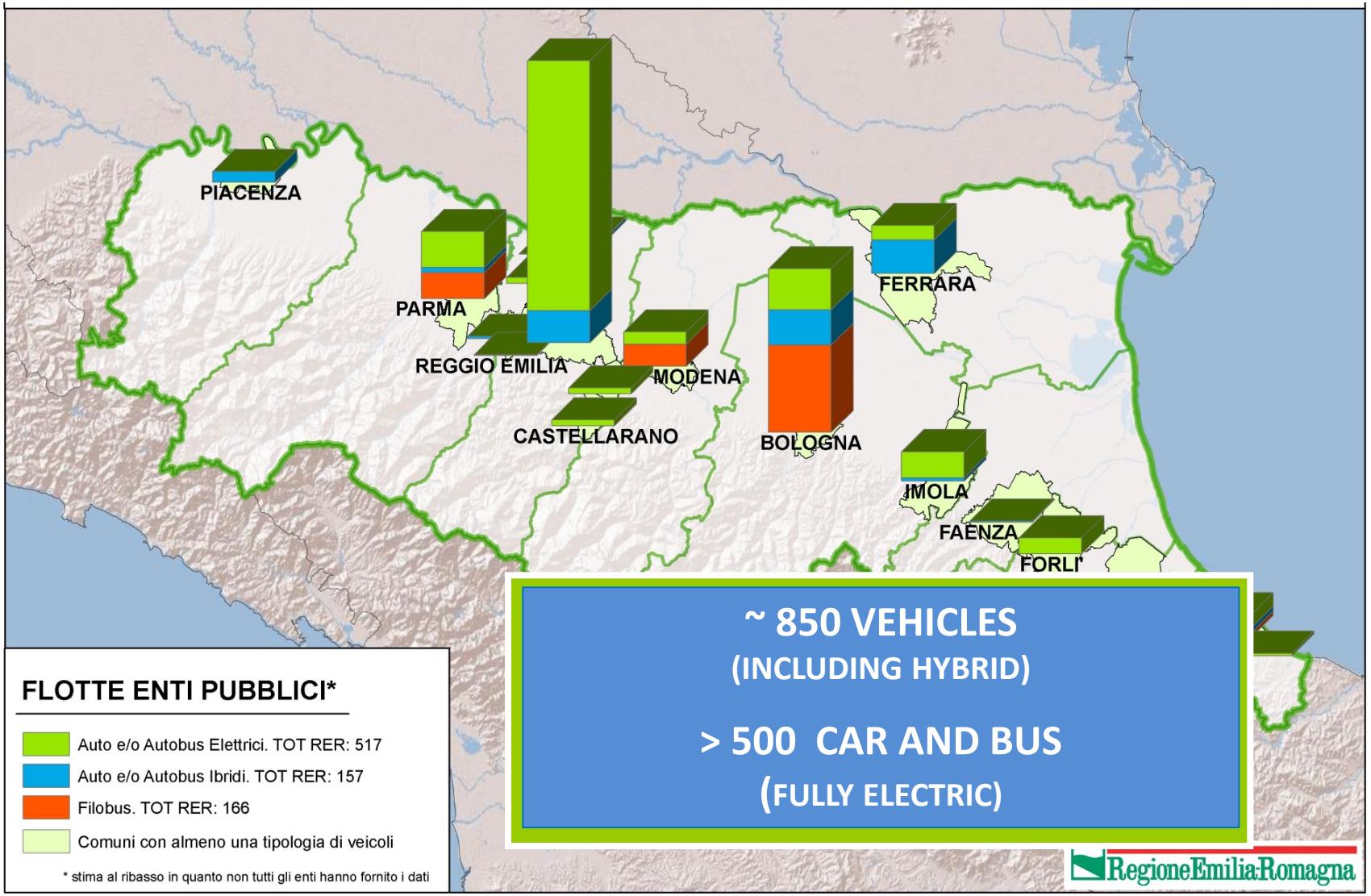
678DPF BUS 2008

mi muovo elettrico
La mobilità sostenibile dell'Emilia-Romagna

9 MLN €
2010-2012

Intermodal transport

FLEET OF ELECTRIC VEHICLES IN PUBLIC ADMINISTRATION



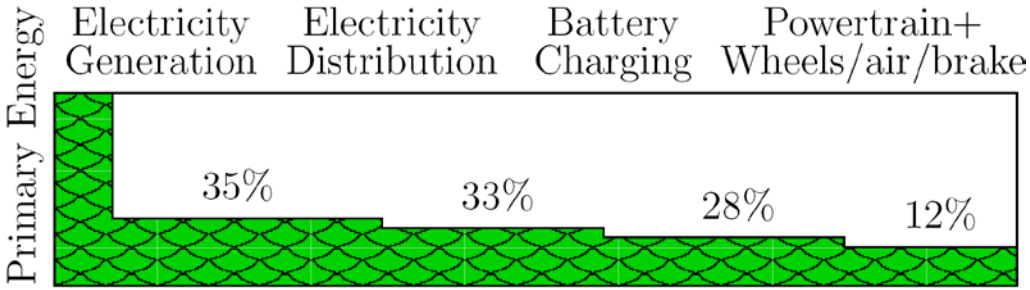
ALTERNATIVE PROPULSION TECHNOLOGIES

- **Battery electric vehicles**
  Adds weight, costs, limits range, and requires battery disposal

- **Hybrid vehicles (parallel, serial)**
  Fossil-fuel dependent

- **Fuel Cell Electric vehicles (Hydrogen powered)**
  Requires massive new infrastructure and add costs to the vehicle!

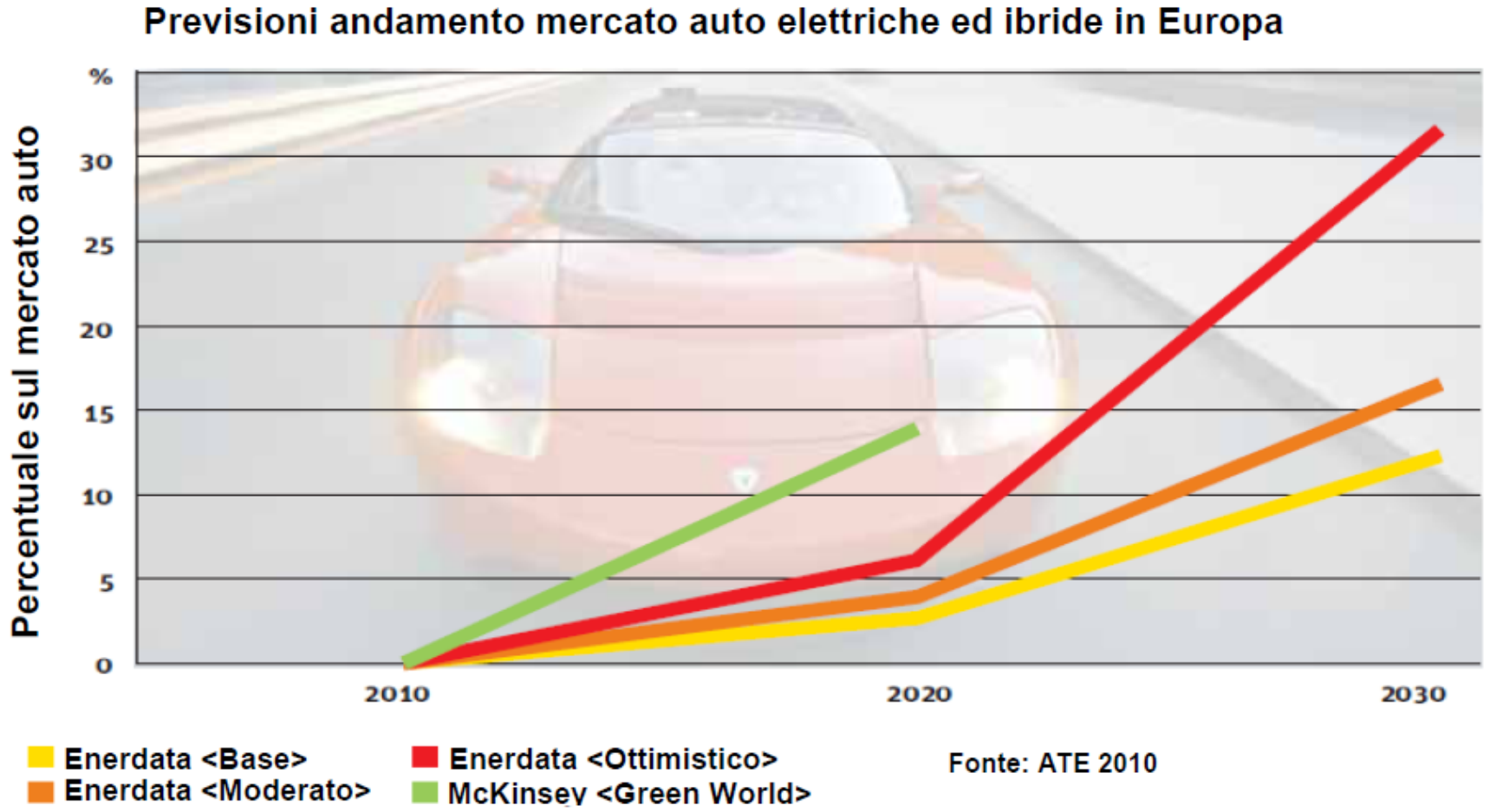
- **Bio-fuels**
  Competition with food production and forests!



Example: for Nissan Leaf

Well – to – Wheel efficiency of Battery electric cars

FORECAST OF DEVELOPMENT FOR ELECTRIC AND HYBRID VEHICLES



Made possible by the INTERREG IVC programme

THE NEED OF A CHARGING INFRASTRUCTURE

SOME FLASH AROUND THE CITY…

THE APPROACH

Electric Mobility Vision at 360°

SUGAR

ELECTRIC MOBILITY REGIONAL PLAN

Agreements with energy providers

Agreements with municipalities

Regional infrastructure

Public recharging station

Interoperability
(between the municipalities and the different energy provider)

mi muovo elettrico
La mobilità sostenibile dell'Emilia-Romagna

MI Muovo Smart card for all mobility services in all region

Contactless Smartcard
RFID tecnology

Rules Harmonization
(LTZ access and parking pricing)

Economic incentives for the electric vehicles

Focus e Monitoring at regional level

European Union
European Regional Development Fund

RegioneEmilia-Romagna

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REGIONS OF EUROPE SHARING SOLUTIONS

Made possible by the INTERREG IVC programme

ONGOING EUROPEAN PROJECTS SUPPORTING REGIONAL POLICIES

THE CIVITAS INITIATIVE IS CO-FINANCED BY THE EUROPEAN UNION

CIVITAS Cleaner and better transport in cities

MIMOSA

- Demonstrate the benefits arising from the adoption of sustainable forms of mobility

EUROPEAN UNION EUROPEAN REGIONAL DEVELOPMENT FUND

CENTRAL EUROPE COOPERATING FOR SUCCESS.

RAILHUC

- Improve Central Europe's interconnectivity by an intermodal integration of rail hubs at different levels and with LPT (TEN-T -> regional/local transport)

INTER REGIO RAIL

- Improve Regional Rail Transport in Central Europe

Life

MHYBUS

- Development of a prototype bus that can use a mixture of methane and hydrogen (15 %)

I.MO.S.M.I.D.

- Governance System for sustainable mobility

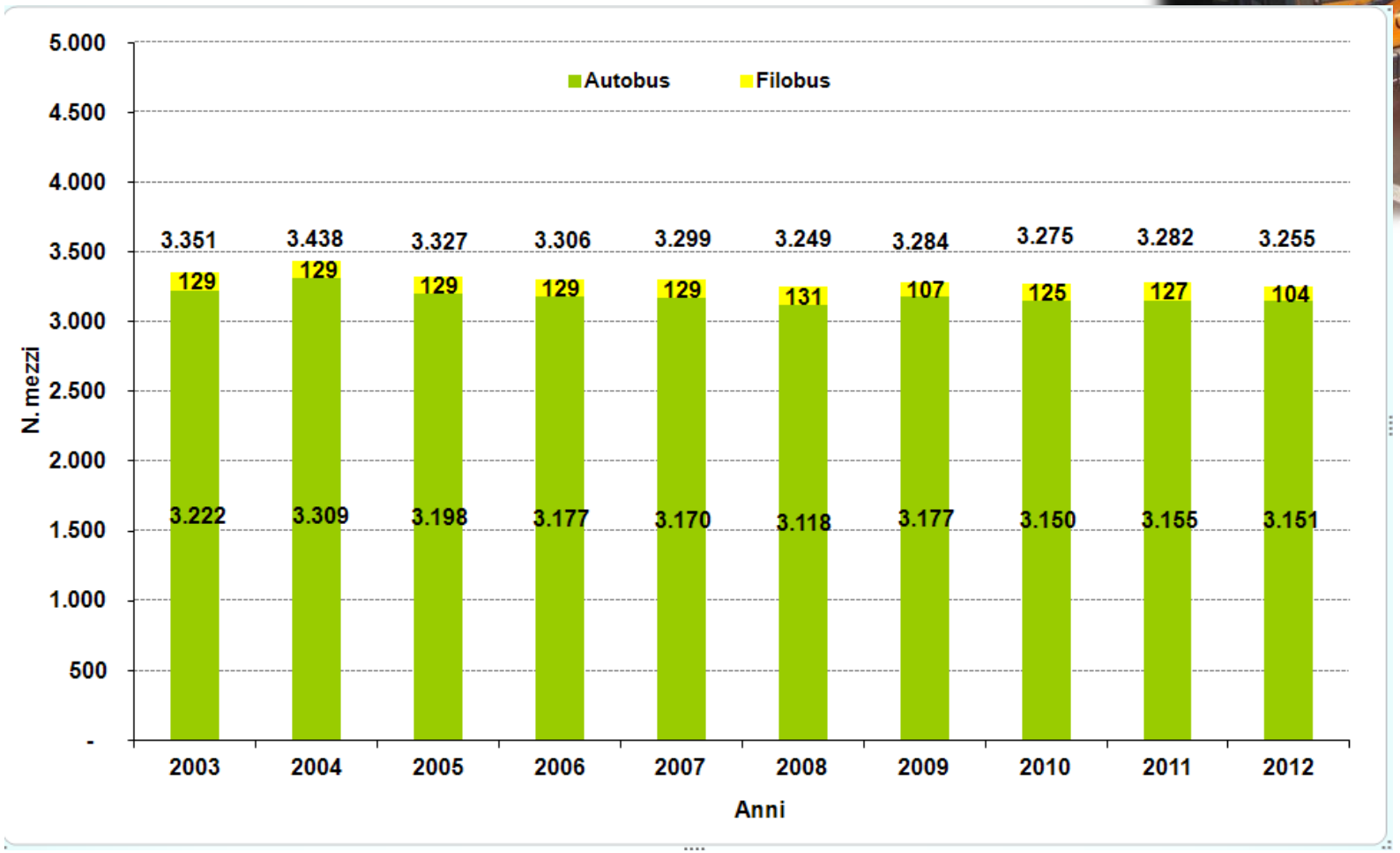
INTERREG IVC INNOVATION & ENVIRONMENT REGIONS OF EUROPE SHARING SOLUTIONS

ecotale EXTERNAL COSTS OF TRANSPORT AND LAND EQUALIZATION

epta

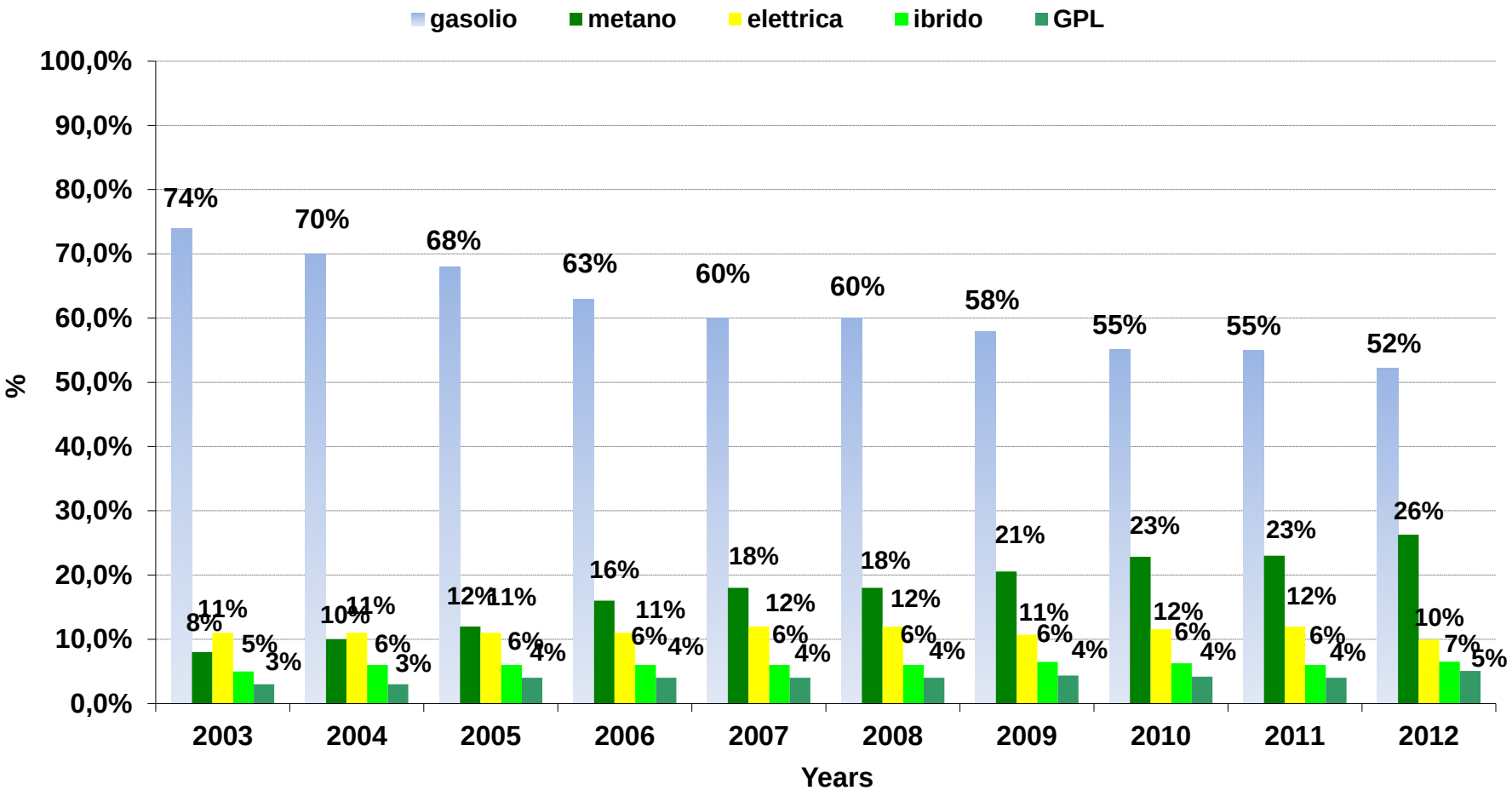
- Planning and investment decisions based on global transport costs
- European model for Public Transport Authority as a key factor leading to transport sustainability

REGIONAL BUS AND TROLLEY BUS FLEET



In Bologna circulate more than 1000 buses

REGIONAL BUS AND TROLLEY BUS FLEET (ONLY URBAN FLEET)



In 10 years the number of Diesel buses is decreasing (74% to 52%) and the number of CNG is increasing (8% up to 26%)

CIVITAS MIMOSA

CIVITAS MIMOSA: SOME INFORMATIONS ABOUT THE PROJECT

Planned measures: 70 (18 in Bologna)

Costs: ~ 24 Mln € (~ 6,5 Mln € for Bologna)

EU Co-funding : ~ 15 Mln € (~ 4 Mln € for Bologna)

Duration: 4 years (2008 – 2012)

Involved cities: Bologna, Utrecht (NL), Danzica (PL), Funchal (P) e Tallin (EST)

Project Coordinator: Municipality of Bologna

Partners: 17

In Bologna:
Municipality of Bologna, ATC LPT company, SRM, Emilia-Romagna Region

RER MAIN ACTIVITIES ALREADY COMPLETED

Dissemination:

- ❑ reporting activities on initiatives hold by RER and the other local partnenrs (Municipality of Bologna, ATC ed SRM)
- ❑ updating of the Measure implementation status in the civitas website
- ❑ contribution to the newsletter and leaflets realization

MI MUOVO information campaign:

- ❑ a specific information campaign on MI MUOVO project has been carried out
- ❑ several experience exchange with the European partners

Co-operation with ATC on the research and test activities for alternative fuels:

- ❑ a study on the ATC bus fleet consumption and emission has been carried out
- ❑ a comparative research on the different existing alternative fuels (electric, hydrogen, hybrid) has been conducted; a report on this study is available on MIMOSA the web site
- ❑ a tender has been awarded to VAN HOOL for the procurement by ATC of 2 12 meter long Hybrid buses in order to realize the foreseen tests

RESULTS OF THE SPERIMENTATION OF TWO HYBRID BUS SUPERCAPACITOR EQUIPPED IN THE CITY OF BOLOGNA

Thanks to the Mimosa project the city of Bologna has created a mini-fleet of two hybrid buses with super-capacitors and tested in real conditions of service.

Characteristics of the vehicles:

Brand: Van Hool

Tipology: A330 Hyb

Length: 12 meters

Largeness: 2,55 meters

Cost of single bus: 350.000€

Number of seats: 24

Standing: 56

The study conducted by TPER has point out:

- the decrease of operating costs - the new hybrid vehicle is equipped with supercapacitors allows to overcome the problem of maintenance of the batteries;

- the decrease in fuel consumption compared to the traditional ones.

CONTRACT AWARD AND SUPPLY OF THE BUSES (1/2)

(MAY 2011- DEC 2011)

The contract was awarded on May 2011 and buses were completed on December 2011.
The selected buses are equipped with **innovative super capacitors** that **replace conventional electric batteries**.

Compared to **traditional** hybrid vehicles, they offer **a considerable reduction in fuel consumption through lower exhausted gas emissions**.

Maintenance costs are also reduced, as they do not need the deployment of battery charging stations at the bus depots, nor the periodical substitution of the conventional costly batteries, known to wear out quickly.

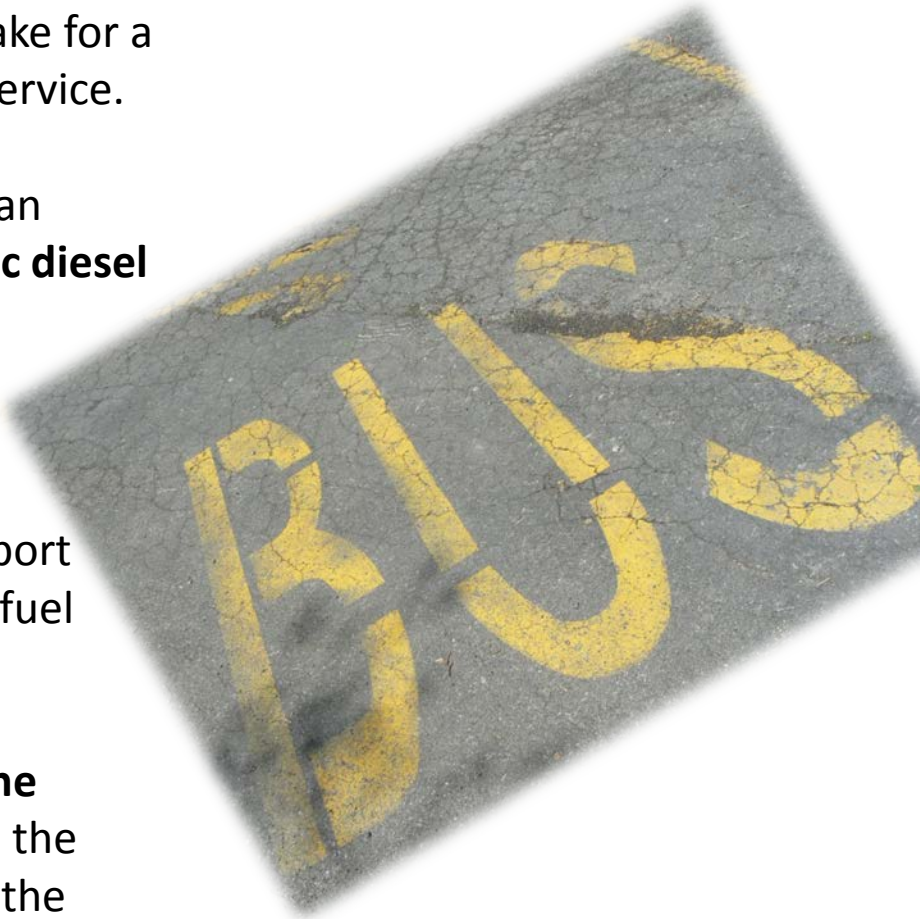
Super capacitors can stand a significantly higher number of charge-discharge cycles and last longer than conventional batteries, making both the super capacitor and vehicle more environmentally friendly.

CONTRACT AWARD AND SUPPLY OF THE BUSES (2/2)

(MAY 2011- DEC 2011)

Aditionally, as super capacitors are not as restraint by low battery charge levels, these new buses make for a more reliable, constant and long serving bus service.

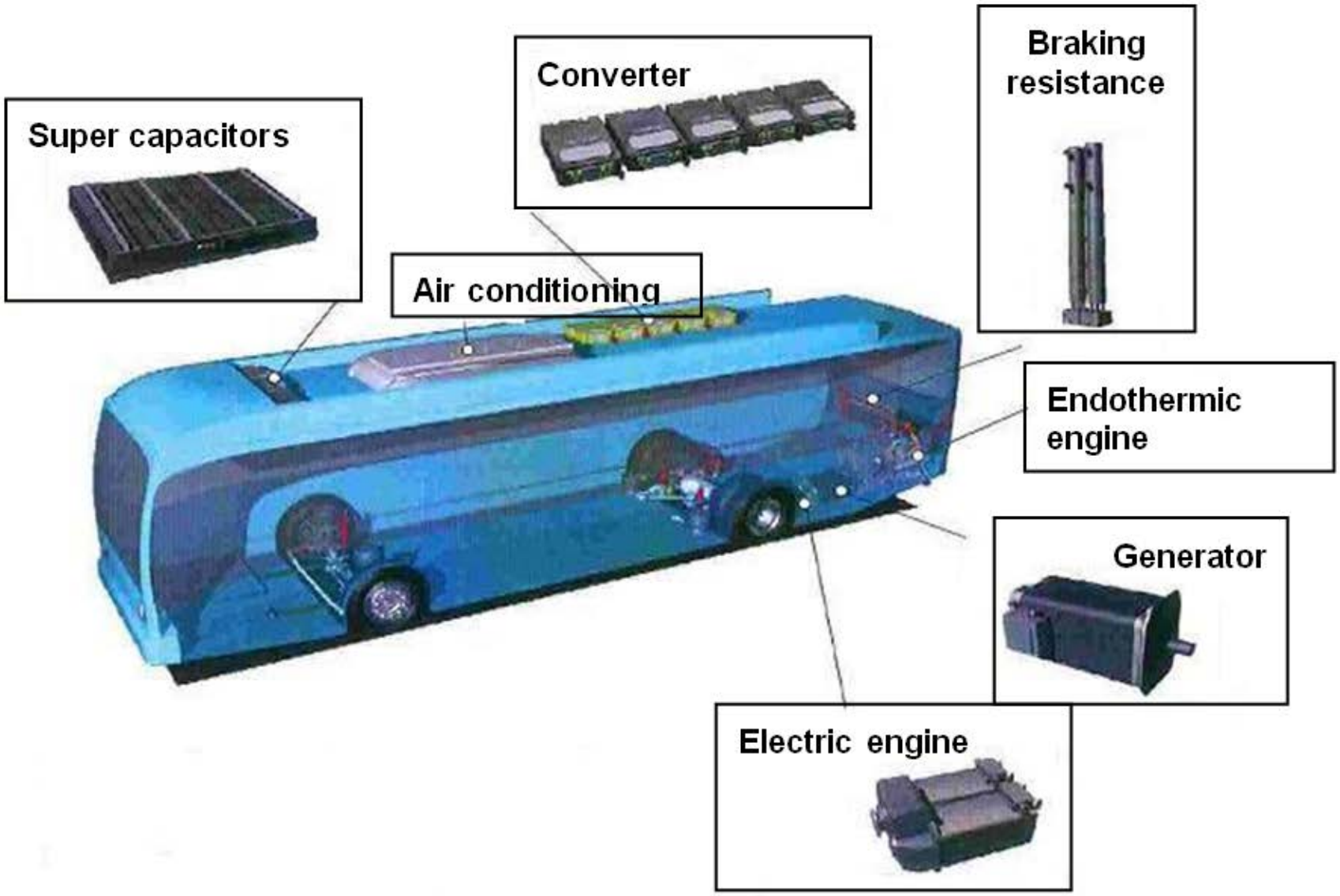
The two Van Hool vehicles are equipped with an **electric generator** powered by an **endothermic diesel engine**.



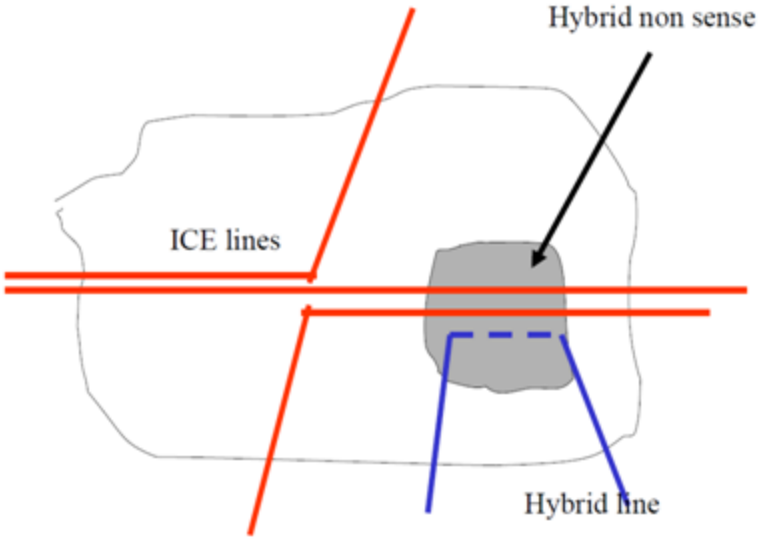
The generated energy is stored by the super capacitors and **released** by the electric drive engine during the acceleration phases, to support the endothermic diesel engine, thus reducing fuel consumption and improving the performance.

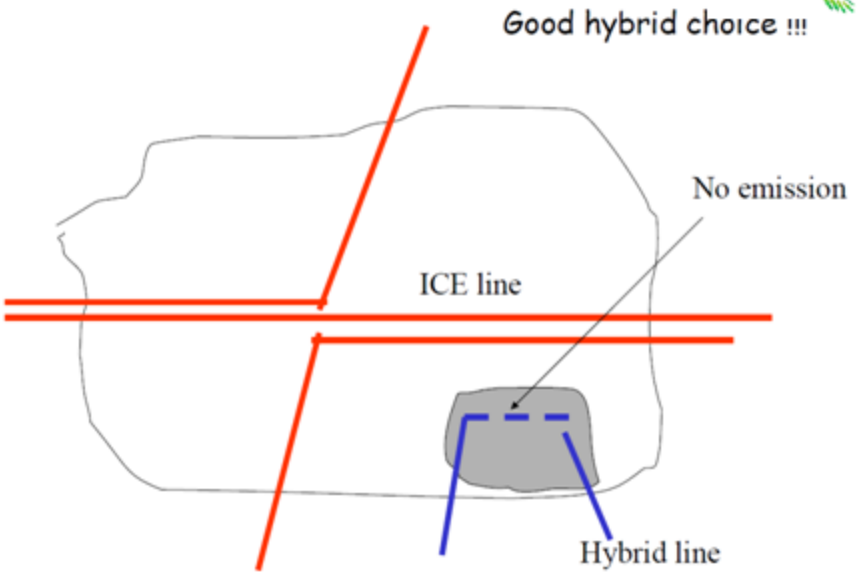
During the **braking and decelerating phases the energy produced** by the generator is driven to the super capacitors to be stored. In other words, the super capacitors work like a type of super condenser, which can **very rapidly store and give back energy in great quantities**.

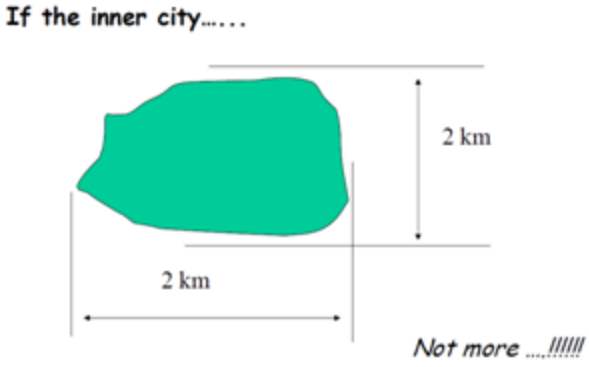
INNOVATIVE SUPER CAPACITORS
(1/2)

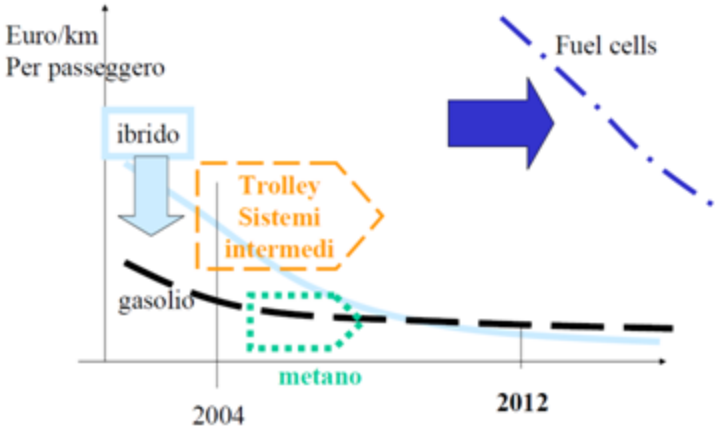


INNOVATIVE SUPER CAPACITORS
(2/2)



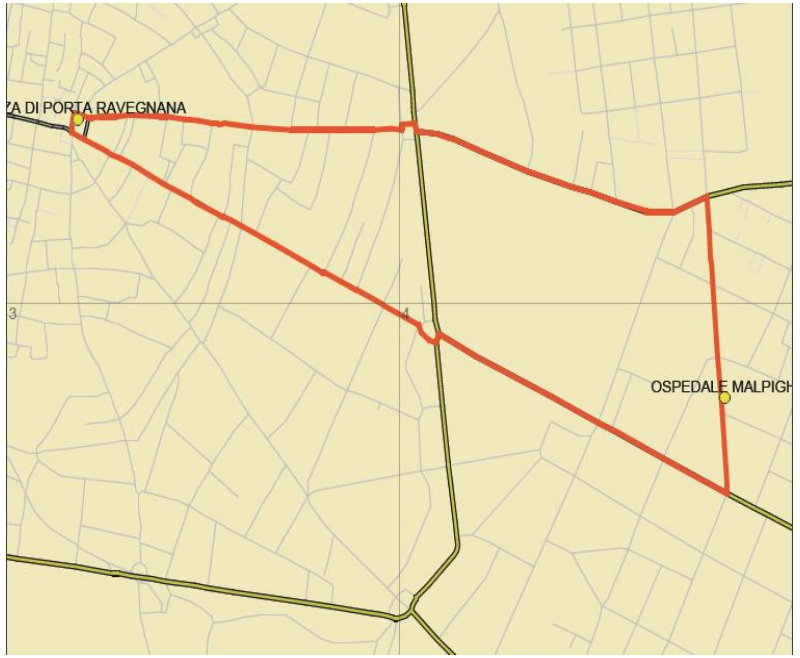






HYBRID BUSES IN BOLOGNA URBAN AREA

From April 2012 the 2 hybrid buses are **operating in Bologna urban area**: from Monday to Friday they cover varied urban lines to test the performances on different routes.



On Saturdays and Sundays the vehicles operate on the new shuttle line “T” recently created to connect the city centre to the parking area Sant’Orsola during the “T-days” (main line data: route length 4,126 km, travelling time 22 minutes).

During T-days the circulation on the main three streets of the city centre is allowed only to pedestrians and bicycles.

The service data collected and the feedback from drivers are very positive:

- the vehicles demonstrated reliability during the service
- fuel consumption are good: about 2,5 km/l with the air conditioning system working (both for drivers and passengers compartments)
- the vehicles have a noiseless engine appreciated from drivers and passengers

CONSUMPTIONS (1/2)

Data concerning fuel consumption of the innovative Hybrid Buses were collected in real service conditions. From these data the average consumption is **2,52 Km/l,** equivalent to: 39,68 litres/100 km.

The average daily consumption is about 80 litres for a daily service of 200 km. Data refer to the summer season with an intensive use of the air conditioning system.

Emission comparisons (new hybrid bus Van Hool/Traditional hybrid vehicle operating on the TPER fleet in the same service conditions

Description	Unit	Innovative hybrid vehicle Van Hool (with supercapacitor)	Traditional hybrid vehicle (with batteries)
Specific consumption	l/km	0,40	0,54
Emissions CO2 (extimation)	gr./km	1.052	1.431
Emissions CO (extimation)	gr./km	0,09	1,19
Emissions NOX (extimation)	gr./km	6,67	9,01
Emissions HC (extimation)	gr./km	0,04	0,06
Emissions PT (extimation)	gr./km	0,22	0,3

With regard to CO2 emissions, we estimated 212 kg of CO2 per day, calculating 2.650 gr of CO2 for each litre of Diesel fuel (this calculation uses standard coefficients for CO2 estimation).

CONSUMPTIONS (2/2)

Description	Unit	Innovative hybrid vehicle Van Hool (with supercapacitor)	Traditional hybrid vehicle (with batteries)
Batteries life cycle	Years	No batteries	3
Availability (days per month)	%	99,38	75
Fuel distance	km	About	About

The study conducted within the measure identified **the hybrid buses as the best solution for Bologna's situation**. This solution can be easily adopted also from companies that do not have the possibility to invest in infrastructures that are required for trolleybuses, electric vehicles and natural gas buses.

Two innovative hybrid vehicles equipped with supercapacitors were realized and are operating since April 2012 with very positive results in terms of reliability and performances.

RESULTS AND COMMENTS

❑ Up-scaling of results

The hybrid bus is a simple solution that can be adopted to develop and environmental friendly bus fleet: hybrid technology guarantees low emission levels and the introduction of this vehicles does not imply infrastructural investments.
We think that the purchase investment plan of TPER for the next year will foresee the introduction of further hybrid vehicles.
We also think that this solution can be easily adopted from other transport companies that want to improve the environmental sustainability of their fleets.

❑ Appraisal of evaluation approach

The evaluation methodological approach could be improved with the measurement of the emission levels in real operation conditions (for the current evaluation we only extimated them). This would imply an agreement with research institutes that have the necessary instruments (very expensive) to measure emissions. The instruments would be installed on board and data would be collected during the real operation of the bus.

Summary of evaluation results

Key results of the evaluation can be summarized as follows:
Decrease in operating costs – The new hybrid vehicle is equipped with supercapacitors that do not need to be changed while traditional hybrid vehicles have batteries that needs to be substituted every 3 years with a cost of about 30.000,00 euro.
Decrease in consumption – Data collected in realaservice condition demonstrated a saving in fuel consumption of about 26% of the new hybrid vehicles compared with the traditional ones.

LIFE+ MHYBUS


Progetto sperimentale idrogeno-metano
per autobus a emissioni minime
A.T.M.
Dài de' gas
idrogeno + metano = più energia e aria pulita

MHYBUS PROJECT (1/5)

The european project MHyBus on Hydromethane

Emilia Romagna Region is coordinating the project MHYBUS co-financed by the European Commission in the framework of the LIFE + program 2007. The project implementation started in February 2009 and will be completed in June 2013.

MHYBUS intends to verify if a blend made of **Hydrogen and methane** is less polluting and more energy efficient than natural gas alone.

For this purpose the project aims at testing (on the road and with passengers on board) a bus prototype powered by a blend of methane with at least 15% Hydrogen, according to the final result of a preliminary experimentation conducted in a private ENEA test circuit.

Project Partners are:

ENEA

ASTER

ATM di Ravenna

SOL S.p.A.

MHYBUS PROJECT (2/5)

ENEA TEST BENCH

The first test phase aiming at finding the most energy efficient Hydrogne percentage has been completed. A bus engine was bought and tested on the ENEA test bench in Casaccia (Rome).

The test results were:

- the best percentage is 15%
- A CO2 emission reduction of 11% was obtained

Afterwards the engine was transferred to **Naples CNR** Engines Research Institute to carry out the mandatory tests foreseen and controlled by the Ministry of Transport.

In November 2011 the engine will be installed on the prototype bus by the bus manifacture BREDAMENARINI in order to start up the **on road test.**

A study by the University of PISA has verified that Hydromethane powered buses are not dangerous both for drivers and passengers**.**

MHYBUS PROJECT (3/5)

Hydromethane filling station

- For the quick filling up during the bus service, the project foresees the realization of an Hydromethane station at the SOL plant in Ravenna.

- All the requested permissions (for the safety for instance) have already been obtained.

- In the next future a special compressor will be transferred from the ENEA test site in Casaccia (Rome) to the SOL plant in order to get the right pressure on filling the bus.

ENEA Compressor

SOL plant in Ravenna

MHYBUS PROJECT (4/5)

Dissemination atcivities

An informative website dedicated to MHYBUS project has been realized and is regularly updated

The website contains a session called "**the hydromethane community**" to promote the experience exchange on similar projects running at national and European level.

MHYBUS PROJECT (5/5)

Actions to be fulfilled within June 2013

The prototype bus will have to cover **45.000 km in order to be homologated**.

A **communication campaign** addressed to LTP users will be conducted on board and at bus stops to inform passengers.

Tecnichal guidelines for the bus fuel shift from CNG to HCNG have to be elaborated.

The project foresees a **HCNG cost benefit analysis** (also through the hydrogen production from renewable sources) in order to evaluate the fuel shift feasibility for an existing CNG bus fleet.

The project outputs will be disseminated through a **specific dissemination campaign**.

I.MO.S.M.I.D. PROJECT – LIFE+ 2009

Integrated MOdel for Sustainable Management of Mobility in Industrial Districts

Regione Emilia-Romagna

Provincia di Reggio Emilia

ACT Agenzia Locale per la Mobilità

Comune di Correggio

EN.COR SRL Energia Correggio Società a Socio Unico

Diputació Barcelona

I.MO.S.M.I.D. PROJECT: objectives

The Project aims:

1) To identify and define a governance model based on sustainability criteria

2) To develop an innovative and integrated approach for the Mobility Management of industrial districts

3) To promote MODE shifting, to face the growing demand for transports, from private to local public transports, and notably to zero emissions vehicles: in order to save energy and reduce at the same time local CO2 emissions

4) To **integrate transport and energy** in a system capable of taking advantage from **renewable energy produced** within the industrial districts of the Municipality of Correggio, to support the local transport policy of sustainability

I.MO.S.M.I.D PROJECT: actions

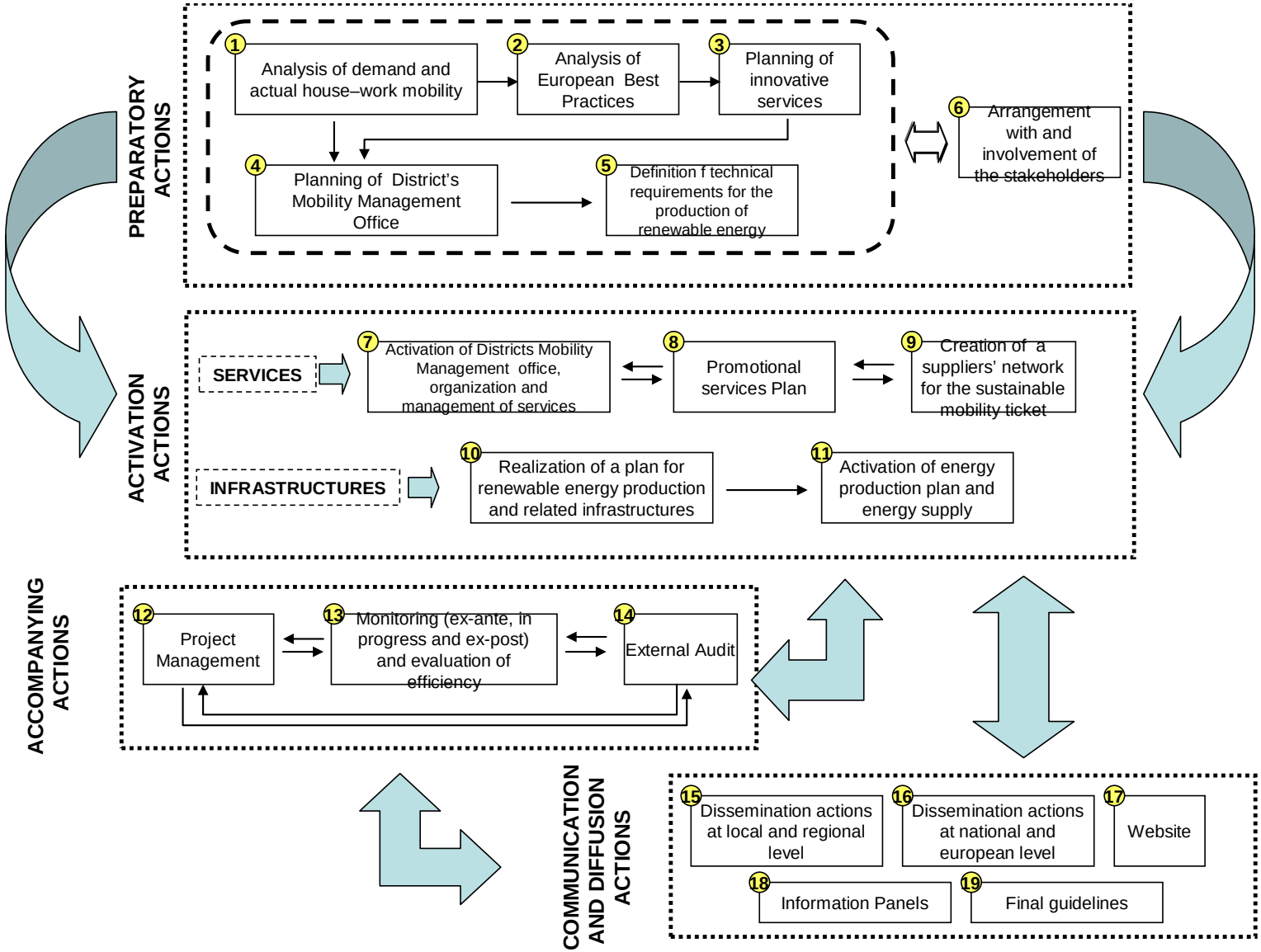
The integrated model of sustainable mobility management in the industrial districts will be developed through:

1) the establishment of a coordination structure, namely the **District Mobility Management's Office**

2)the activation of **car pooling services**

3) the activation of **innovative services** (i.e. on demand transports through the use of hybrid buses - electric power and natural gas / diesel clean)

INTERRELATIONSHIPS AMONG THE VARIOUS PROJECT ACTIONS



RENEWABLE FUELS

Analyzing existing literature's data and pilot experiences of other areas we have tried to compare the various possibilities of using renewable fuels, coupled with transport technology.

Were identified for each type's strengths and limitations, as well as cost and energy efficiency indices.

Engine technology	Usable fuel
Endothermic	Fossil fuels
	Pure vegetable oil
	Biodiesel
	Ethanol
	Biogas
	Syngas
	Hydrogen
Electric	From fossil or nuclear
	From hydrogen
	From solar photovoltaic
	From hydroelectric
	From tidal force
	From wind power
	From biomass plants
	From solar thermal concentration
Compressed Air	Air

PRODUCTION FUELS COST RELATED TO ENDOTHERMIC ENGINE

Fuel	Estimed costs per TOE (Tonne of Oil Equivalent)	Notes
Biogas	€ 170/ TOE	Average price considering to produce it with anaerobic digestion plant corn silage feeded. (by business plans plant Encor)
Syngas	€ 280/ TOE	Average price considered to produce it with gas plant through the use of forest's wood. (by business plans plant Encor)
Pure vegetable oil	€ 500-900/ton ► € 550-1000/TOE	The market price of seed is significantly variable during the year owing to speculative effects. The reported minimum value can be considered the actual average cost of production, while the oil market can get on average to the value indicated and even higher, usually for short periods.
Biodiesel	€ 700-1000/ton ► € 680-1135/ TOE	The price of biodiesel production depends directly on the purchase price of the seed, subject to market speculation. The minimum value corresponds to the actual cost of production, while the other value can be reached at particular times of the market of the seed.
Hydrogen	€ 1800/ TOE	Assuming a market price of euro 5.5 / Kg considered to ambient temperature and pressure.
Ethanol	€ 1000/ton ► € 1950/ TOE	Average market price for U.S. productions.

The **EROEI** Index measures the amount of energy derived from a plant in its lifetime compared with that used to build and maintain it.

Higher is the value of the EROEI Index and **more interesting** is the technology from the environmental and energy perspective.

Processo	EROEI (Cleveland)	EROEI (Elliott)	EROEI (Hore-Lacy)	EROEI (Altri)
Biomasse		3 - 5	5 - 27	
Idroelettrico	11,2	50 - 250	50 - 200	
Eolico		5 - 80	20	
Geotermico	1,9 - 13			
Solare • Collettore • Termodinamico • Fotovoltaico	 1,6 - 1,9 4,2 1,7 - 10	3 - 9	4 - 9	< 1
Bio-Etanolo • Canna da zucchero • Mais • Residui del mais	 0,8 - 1,7 1,3 0,7 - 1,8			0,6 - 1,2
Bio-Metanolo (Legna)	2,6			

With regard to the I.MO.S.M.I.D. project the choice of the coupling propulsion technology / fuel has been made on the basis of previous data and some other constraints of the project, as summarized below:

With regard to the Transport Vehicles

- Suitable vehicles for car pooling and car sharing;
- Vehicles designed to carry 4-9 people (no dedicated driver);
- Possibilities of renting existing commercial vehicles;
- Competitive vehicles from economical point of view;
- Suitable Vehicles to the movement along medium/short distances.

With regard to the used Fuel

- production and availability in the local area;
- coherence between production and the amount of energy used (25 vehicles);
- use of fuels with minimal impact (not just with regards to CO2).

The analysis of these parameters revealed the optimal choice of the combination **elettric engine** and energy produced from **fotovoltaic** plant.

I.MO.S.M.I.D PROJECT: OUTCOMES/RESULTS ACHIEVED (1/2)

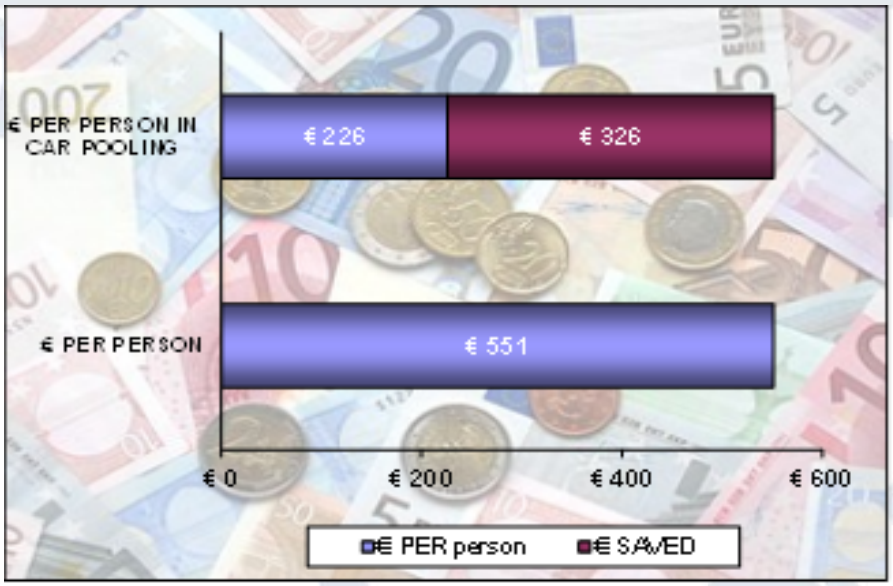
- A significant **reduction of the number of vehicles** that circulate within the district road network:50-80 circulating cars less compared with the initial situation, i.e. at least 200.000 driven kilometers saved per year

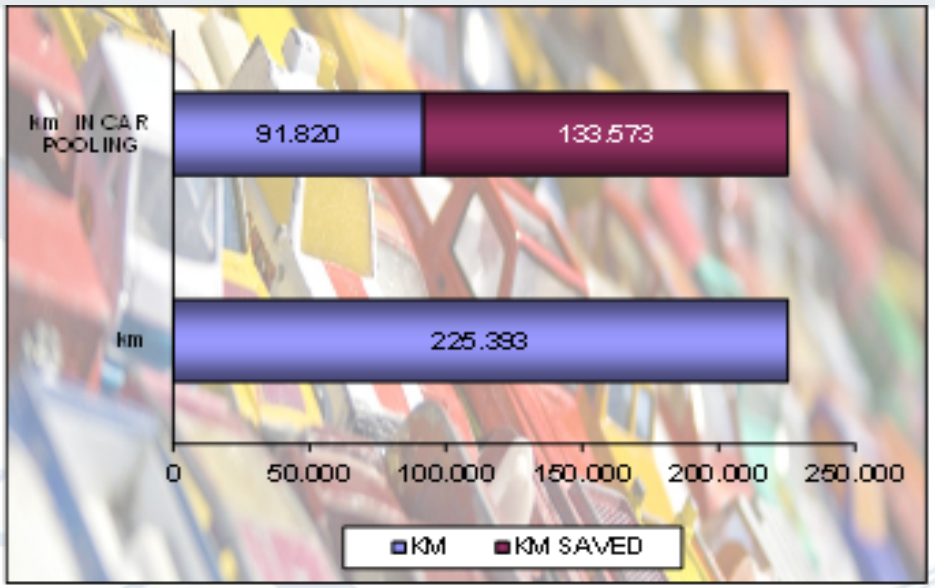
- A definition of a **comprehensive methodology** (analysis and project reports) and an assessment of the success/failure factors of the implemented measures (monitoring report) in order to define "good practice" feasible in similar contexts to concerned

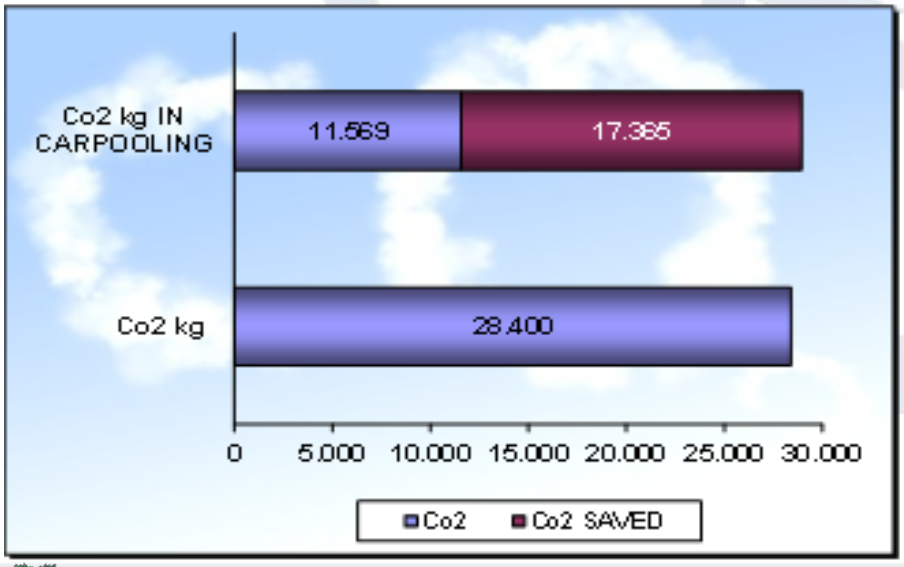
- A substantial **reduction of acoustic and pollutant emissions** in the atmosphere; for example when it comes to carbon dioxide, the objective is to achieve a reduction of 20 tons per year

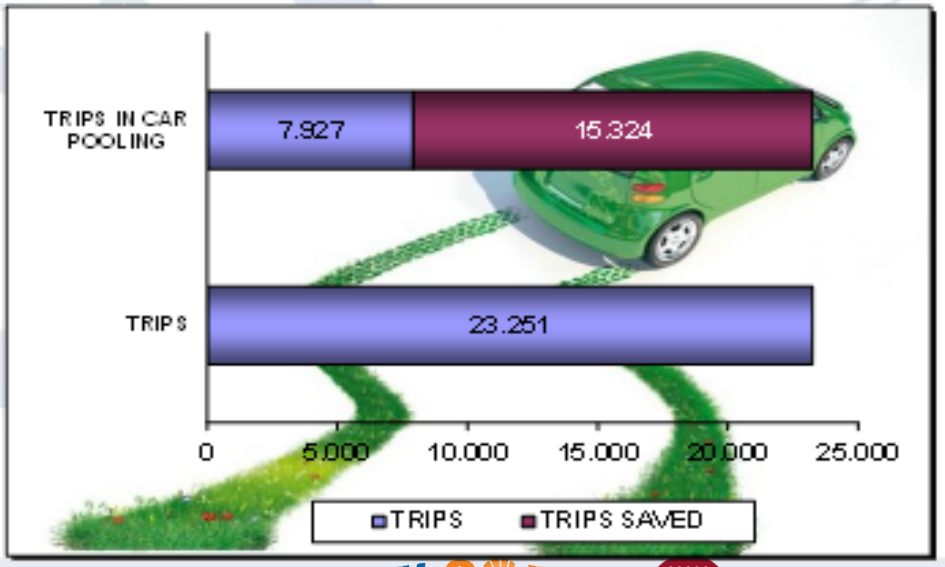
- A general **reduction of traffic congestion and of road accidents number** with advantage for motorists' and pedestrians' safety

I.MO.S.M.I.D PROJECT: OUTCOMES/RESULTS ACHIEVED (2/2)

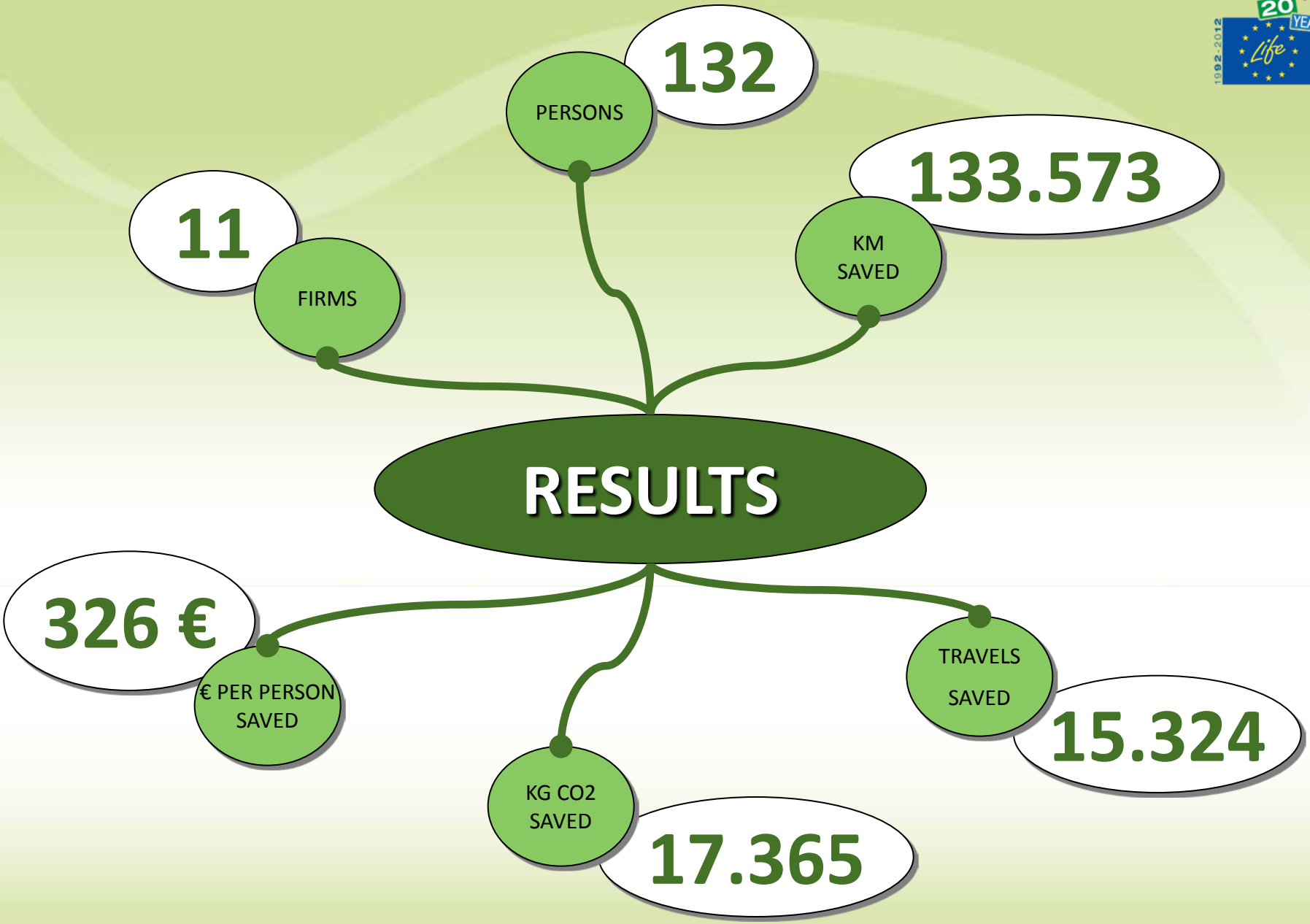








PROVINCIA DI REGGIO EMILIA
Regione Emilia-Romagna
ACT
COMUNE DI CORREGGIO
EN.COR SRL Energia Correggio a socio unico
Diputació Barcelona


RESULTS
PERSONS
132
FIRMS
11
KM SAVED
133.573
€ PER PERSON SAVED
326 €
KG CO2 SAVED
17.365
TRAVELS SAVED
15.324

After the first 10 months of performing the carpooling…

91.000 km traveled in car pooling

=

4 round trips Correggio – Singapore

=

2,5 turns on the equator around Earth

17.000 kg CO2 saved

=

CO2 absorbed by 800 trees in urban environments

Problem to be solved

- Transport systems are responsible for urban air pollution and their efficiency affects our daily lives and productivity.

- All transportation modes consume energy; such energy now is mostly derived from combustion, mainly of fossil fuels and, in general, of oil-derived.

- Combustion inevitably produces CO2 and many other substances, depending on specific fuel and combustion characteristics, among others Nitrogen Oxides, Sulphur Oxides, Heavy Metals, Volatile Organic Compounds (VOC), Particulate Matters (PM), apart from Carbon Monoxide (CO) because of not perfect combustion.

- At certain concentrations, such substances **change physical and biological characteristics** of the air (mainly of the troposphere) with **hard consequences on health, climate and weather precipitations characteristics**.

- Therefore, electric traction is the **best choice** in terms of local impact

State of the Art of Clean Vehicles Technology: issues and technology measures

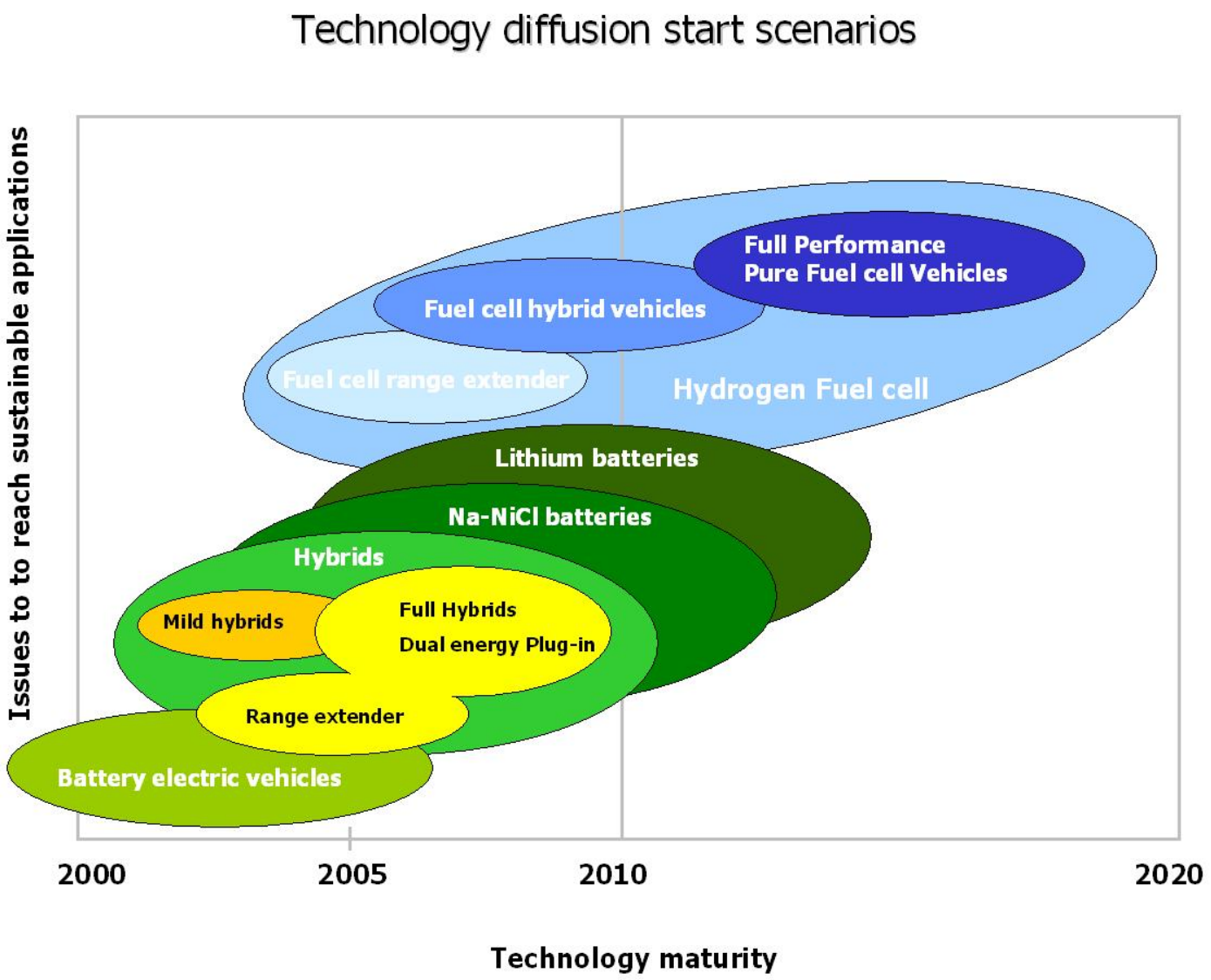
Effects of the different technologies (* positive - / neutral-depends)

	Conven. vehicles	Electric vehicles	Hybrid vehicles	FC electric vehicles
Noxious emissions & noise	*	***	**	***
Energy saving	*	***	**	****
Performance: range and speed	***	*	***	**

State of the Art of Clean Vehicles Technology: problems and breakthroughs

	Electric vehicles	Hybrid vehicles	FC electric vehicles
Technological breakthroughs	*	/	***
Infrastructural cost	*	/	****
Infrastructural impact	/	/	***

CONCLUSIONS (1)



CONCLUSIONS (2)

- The introduction of innovative transport system for public transport in most of Cities and metropolitan areas could **improve significantly** the effectiveness of local movements both in terms of urban environment and economic efficiency.

- Quoting the IEA 'Each additional bus provides large benefits. Regardless of whether a bus is "clean" or "dirty", if it is reasonably full it replaces anywhere from 10 to 40 other motorised vehicles'.

- We could add that new public transport systems based on environmental friendly technologies, like those presented in this paper, could represent the answer for the future transport systems **if we take into account the better safety, the noise reduction, the energy saving, the improvement of the urban environment due to less pollution and less land 'taken' by running or parked cars**.

Thanks for your attention

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